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Development of Chemistry E-Modules Based on Problem Based Learning (PBL) on Colloidal Material at SMAN 2 Muaro Jambi

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ABSTRACT

Pendidikan merupakan salah satu tolok ukur kemajuan suatu bangsa. Suatu bangsa dapat dikatakan maju, salah satunya apabila pendidikan dalam bangsa tersebut maju. Seiring dengan perkembangan globalisasi dan ilmu pengetahuan serta teknologi, pendidikan pun terus mengalami kemajuan sesuai dengan perkembangan zaman. Dalam konteks pendidikan, tujuan utamanya adalah menghasilkan individu yang tidak hanya memiliki pengetahuan, tetapi juga kemampuan berpikir kritis yang kuat. Pendidikan kimia di SMA seringkali menghadapi tantangan dalam menyampaikan materi abstrak seperti koloid kepada siswa pada saat kegiatan pembelajaran. Penelitian ini bertujuan untuk mengembangkan e-modul materi koloid berbasis Problem Based Learning (PBL) untuk membantu siswa memahami materi abstrak seperti koloid. Hal ini telah dibuktikan melalui beberapa penelitian terdahulu yang mengembangkan e-modul pada beberapa materi abstrak lainnya dan terbukti efektif. Oleh karena itu, e-modul ini berpotensi untuk membantu siswa memahami materi koloid.

Education is one of the benchmarks of a nation's progress. A nation can be said to be advanced, one of which is if education within the nation is advanced. Along with the development of globalization and science and technology, education continues to progress in accordance with the times. In the context of education, the main goal is to produce individuals who not only possess knowledge, but also strong critical thinking skills. Chemistry education in high school often faces challenges in conveying abstract materials such as colloids to students during learning activities. This study aims to develop an e-module for colloid material based on Problem Based Learning (PBL) to help students understand abstract materials such as colloids. This has been proven through several previous studies that developed e-modules on several other abstract materials and proved effective. Therefore, this e-module has the potential to help students understand colloid material.

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INTRODUCTION

Education is one of the benchmarks of a nation's progress. A nation can be said to be advanced, among other things, if education within that nation is advanced. With the development of globalization and science and technology, education continues to evolve with the times. In an educational context, the primary goal is to produce individuals who possess not only knowledge but also strong critical thinking skills. Chemistry education in high school often faces challenges in conveying abstract material such as colloids to students during learning activities.

This is in line with what was conveyed by a chemistry teacher at SMAN 2 Muaro Jambi. Based

on the results of an interview with a chemistry teacher at SMAN 2 Muaro Jambi, information was obtained that in the chemistry learning process for colloids, the teaching materials used were textbooks and student worksheets (LKPD). The results showed that the lesson material was not conveyed effectively and optimally. This certainly affected student understanding and learning outcomes. Therefore, additional learning media are needed in the form of independent and easy-to-use learning media anywhere to enhance students' conceptual understanding.

Colloids are a crucial topic in chemistry. This topic is relevant not only in scientific contexts but also in everyday life, such as in understanding health, the environment, and industry. However, teaching colloids is often limited to understanding basic concepts and places little emphasis on developing students' critical thinking skills. A weak grasp of supporting concepts can lead to difficulties in understanding colloids. This makes it difficult for students to apply theory to problem examples, leading to some students still experiencing difficulties in learning colloids.

This is supported by the results of the needs analysis given to students, where students have difficulty understanding abstract concepts that are far from their surrounding environment, so they need learning media that can help students understand these concepts. Based on this problem, students' critical thinking skills in solving problems are still lacking, so a solution is needed that can improve students' critical thinking skills, such as developing learning media in the form of e-modules. A well-designed module can be an effective tool in improving students' critical thinking by including elements that stimulate critical thinking during the learning process.

In addition to using engaging teaching materials, students will be more engaged if they relate the material to their surroundings. Therefore, teachers are required to choose appropriate learning models that encourage students to actively participate in the learning process. One model considered a potential alternative for improving students' critical thinking skills is problem-based learning (PBL).

Therefore, the researcher will design this e-module with the main objective of improving students' ability in applying the concept of colloids in everyday life, where this e-module is developed using the Hannafin and Peck development model. Through the given scientific problems, students will be given the opportunity to collaborate, analyze, evaluate, and integrate their knowledge in a relevant context. Through the development of a PBL-based colloid e-module with an in-depth approach to the values of Pancasila, students can develop a better understanding of the concept of colloids while increasing awareness and appreciation of moral and social values that are important in community life.

METHOD

This research is a research and development (R&D). This research aims to develop a product in the form of an e-module based on problem solving in colloidal material. The development design used in this study is the Hannafin & Peck development. The reason for using the Hannafin & Peck development is based on the consideration that this model is oriented towards learning products and is a learning design that is presented in a simple and easy to use manner. The selection of this model is also based on the consideration that this model was developed systematically and is based on the theoretical foundation of learning design. The Hannafin & Peck development design consists of three stages, namely the needs analysis stage (need assess), design (design), and development and implementation (develop & implement). The existing stages will be involved through the evaluation and revision process.

RESULTS AND DISCUSSION

Result

The result of this development research is a product in the form of an e-module based on Problem Based Learning (PBL) on colloid material. This media was developed using the Hannafin and Peck development model, which has three stages in development: the needs assessment stage, the design stage, and the development and implementation stage. The assessment was carried out by material experts, media experts, teacher assessments, and student responses, all carried out using an instrument in the form of a questionnaire. This research was conducted only up to the development stage, namely until a small group test consisting of 15 students as respondents.

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Analysis Needs Assessment stage

In this analysis phase, interviews were conducted with chemistry teachers and questionnaires were distributed to students to understand the students' current situation. At this stage, the researcher interviewed teachers at SMAN 2 Muaro Jambi and distributed questionnaires to grade XI students in phase F of SMAN 2 Muaro Jambi via Google Form.

Based on this, the data obtained can be grouped into several aspects, namely:

1. Analysis of Learning Problems

   This analysis aims to determine the current state or description of the problems currently faced in schools, both by teachers as educators and by students. Based on this, the researcher conducted an interview with a chemistry teacher at SMAN 2 Muaro Jambi.

   It was discovered that one of the challenges faced was dealing with fluctuating student enthusiasm, which hindered the learning process. When students were confronted with abstract material, they struggled to understand it, requiring media that could visualize it to make it more tangible and easier to understand.
2. Objective Analysis

   Objective analysis is carried out on media created in line with the desired learning objectives stated in the curriculum. At SMAN 2 Muaro Jambi, the curriculum used is the Merdeka Curriculum.
3. Material Analysis

   The material analysis was conducted by considering the problems that occur in the school environment, especially those faced by students in understanding the concepts taught. Based on the distributed questionnaire, the results showed that students had difficulty understanding abstract material and concepts, one of which was colloids. In the data, 48.4% of students said it was quite difficult and 38.7% said it was difficult to understand.
4. Analysis of student characteristics

   Student characteristic analysis is used to determine student characteristics during learning activities. These characteristics can include interests, abilities, experiences, and learning styles. Based on the questionnaire distributed, students' interest in learning increases when their teachers use learning media. Furthermore, almost all students (64.5%) use smartphones or laptops while studying.
5. Analysis of learning settings

   Based on initial observations, SMAN 2 Muaro Jambi has a computer laboratory and projector making it possible to use e-modules as learning media. Furthermore, a questionnaire distributed to 100 students revealed that 100 students own smartphones, and almost all have laptops, which can sometimes be used during learning activities. Therefore, it can be concluded that the development of a problem-based learning chemistry e-module for colloids is feasible.

The design stage

This stage is the stage where researchers realize the design ideas that have been submitted into reality. Where the creation of e-module media based on Problem Based Learning is carried out based on the design in the existing storyboard. Starting with validation by a team of experts, namely media experts and material experts, then tested on a small group of 15 people until the final product is produced in the form of an e-module based on Problem Based Learning. The creation of this e-module was carried out using the CANVA DESIGN application. In this application, researchers design the e-module starting from making page by page, then combined into an electronic module containing text, images, videos, and animations.

The development and implementation stage

After obtaining the initial product, researchers conducted a direct field trial in the school environment. The initial stage involved subject teachers assessing the developed media before testing it on students. This was to determine whether the developed media was suitable for testing.

The researcher conducted a teacher assessment using a questionnaire instrument containing 13 questions that were later filled in according to the opinion of the chemistry subject teacher for class XI F1 A, Mr. Idkhom Kholid, S, Pd., M.Pd. The results obtained from the questionnaire are as follows:

Table 1. Teacher assessment results

No	Assessment Aspects	Score	Kategori
1	Accurate	18	Excellent

2	Feedback	6	Great
3	Control in learning	4	Excellent
4	Prerequisite abilities	3	Great
5	Easy to use	16	Excellent
6	Custom Views	4	Excellent
	Total Score	47	
	Percentage	90.4%	
	category	Very Good	

Based on the research data above, a total score of 47 was obtained with an average of 3.6154, which when expressed as a percentage yields a result of 90.4%. This can be interpreted as the media can be categorized as very good because it falls within the interval of 42.26-52.00, which is the range of the very good category.With the above data, the researchers were able to proceed to the next stage, namely testing it on students. The testing was conducted in small groups of 15 students, each consisting of five high-ability students, five average-ability students, and five low-ability students in class XI F1A.

Figure 1. e-module trial process

The following are the results of the trial of the chemistry e-module product based on Problem Based Learning on colloid material in class XI F1A SMAN 2 Muaro Jambi, which consisted of 15 students:

Table 2. the results of student responses

Question Number	Respondents															Score
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
1	3	4	4	3	4	4	4	4	3	4	4	3	3	4	3	54
2	3	3	4	4	4	3	3	4	4	4	3	4	4	3	4	54
3	4	4	4	4	3	4	3	4	4	4	3	4	4	4	4	57
4	4	4	4	4	4	3	3	3	4	3	4	4	4	3	4	55
5	4	4	3	4	4	4	4	4	3	3	4	3	4	3	3	54
6	3	4	4	4	3	4	4	4	3	3	4	4	3	3	4	54
7	4	4	4	4	4	3	4	3	4	3	4	3	4	4	3	55
8	4	4	4	4	4	4	4	3	4	3	4	4	4	4	4	58
9	4	4	3	4	3	4	4	4	3	3	3	4	4	4	4	55
10	3	3	4	4	4	4	3	4	3	4	4	4	4	4	3	55
11	4	4	4	3	4	3	3	4	3	4	4	3	4	3	4	54
12	3	4	4	4	4	4	4	3	4	3	3	4	4	4	4	56
13	3	4	3	4	4	3	3	4	3	4	4	4	4	3	3	53
14	4	4	4	4	4	4	3	4	4	4	4	3	3	4	3	56
15	4	3	4	4	3	4	4	4	3	4	4	4	4	4	4	57
16	4	4	3	3	4	3	3	3	4	4	4	4	4	4	3	54
17	4	4	4	4	4	4	3	4	3	4	3	4	4	3	4	56
18	3	3	4	4	4	4	3	4	3	4	4	3	4	3	4	54
19	3	4	4	4	4	4	4	4	4	3	4	3	4	4	4	57
Total Score																**939**
Precentasge																**82,37%**
Category																**Very Good**

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Based on the data in the table above, it can be concluded that the PBL-based chemistry e-module is categorized as feasible because it falls within the 81-100 category range, which is a very good category.

Discussion

The development of a Project-Based Learning-based e-module on colloids was carried out using the Hannafin and Peck development model. This development process involved three main stages: needs assessment, design, development, and implementation. Each stage underwent an evaluation process to create the desired product.

In the needs analysis stage, the researcher conducted several analyses, namely learning problem analysis, learning objective analysis, material analysis, student characteristic analysis, and learning setting analysis. After conducting interviews with chemistry teachers and distributing needs questionnaires to students, the aim was to understand the conditions currently experienced by the students. At this stage, the researcher conducted interviews with teachers of SMAN 2 Muaro Jambi and distributed questionnaires to grade XI phase F students of SMAN 2 Muaro Jambi via Google Form. The problem analysis revealed that one of the challenges faced was dealing with fluctuating student enthusiasm for learning, which hindered the learning process. When students were faced with abstract material, they struggled to grasp it, requiring media that could visualize it to make it more tangible and easier to understand. Meanwhile, the analysis of learning objectives revealed that SMAN 2 Muaro Jambi uses the Merdeka curriculum. Therefore, the learning objectives achieved must align with this curriculum. The researchers then conducted a material analysis. Based on the distributed questionnaire, they found that students had difficulty understanding abstract material and concepts, one of which was colloids. 48.4% of students said it was quite difficult, and 38.7% said it was difficult to understand. Therefore, a solution is needed to make abstract material easier for students to understand by realizing it in a concrete form through learning media. One such medium is an electronic module. However, to make learning more engaging and develop students' 21st-century skills, such as collaboration, critical thinking, and creative thinking, researchers created an electronic module based on the Problem-Based Learning model.

Next is the design stage, where at this stage the first thing to do is create a flowchart and storyboard which will become the basis for developing the electronic module itself. The researchers applied Jean Piaget's theory, where learning will be easier to learn if it can be concreted or made into a real form. This is in line with what Edgar Gale said in Dale's theory of the cone of experience, where the more senses are involved, the easier the learning process will be understood and longer to remember. Here is a picture of Dale's experience concoction. Next, after obtaining the initial product by following the design in the storyboard, the step that must be taken is to validate it with a team of experts, namely material experts and media experts so that the product is suitable for testing.

In the implementation stage, the researcher conducted a teacher assessment first to obtain a product that was suitable for testing with students. During the teacher assessment, the researcher used a questionnaire to ask for teachers' assessments of the media to be developed. Based on the questionnaire, a total score of 47 was obtained with an average of 3.6154, which when expressed as a percentage, resulted in a result of 90.4%. This means that the media can be categorized as very good because it falls within the interval of 42.26-52.00, which is the very good category range. Because the results obtained showed that the electronic module media was said to be very good, the researcher continued the research to the next process, namely conducting a trial on students of SMAN 2 Muaro Jambi class XI F1A, some of whom were taken to form small groups totaling 15 people consisting of 5 students who had good abilities, 5 students who had medium abilities, and 5 other students who had low abilities. Where the results obtained were that the PBL-based chemistry e-module was categorized as feasible because it occupied the range of categories 81-100, which is a very good category.

This is supported by research conducted by Suswati, Umi (2021) which obtained research results, namely that the application of the Problem Based Learning (PBL) learning model can improve student learning outcomes, especially in Chemistry subjects. Furthermore, research conducted by Karlina et al. (2021) aimed to develop a web-based e-module combined with Problem-Based Learning to motivate students to learn about environmental pollution. The results of the research showed that the development of the Problem-Based Learning (PBL) e-module was effective as a learning medium. Then in the research conducted by Arrozani, Alfi (2022) obtained the results of the colloidal practicum module based on Problem Based Learning valid, with a validation value of the characteristic aspect of 3.54 (very valid),

the quality element aspect of 3.62 (very valid), the linguistic aspect of 3.80 (very valid) and the stage aspect of Problem Based Learning 3.60 (very valid). And the colloidal practicum module based on Problem Based Learning can be said to be effective because the results of the activity observation are 96% practicum (Very Good) and the value of the practicum module is 92.93 (Very Good).

CONCLUSION

Based on the research results, it can be concluded that the Problem Based Learning-based chemistry e-module has obtained a validity value of 82.37%, categorized as very good. Therefore, this e-module can be used as a learning medium to help students understand the concepts of colloids in phase F chemistry lessons in high school.

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